



# Independent Testing of Locata: *A New High Accuracy Indoor Positioning Systems*

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Never Stand Still

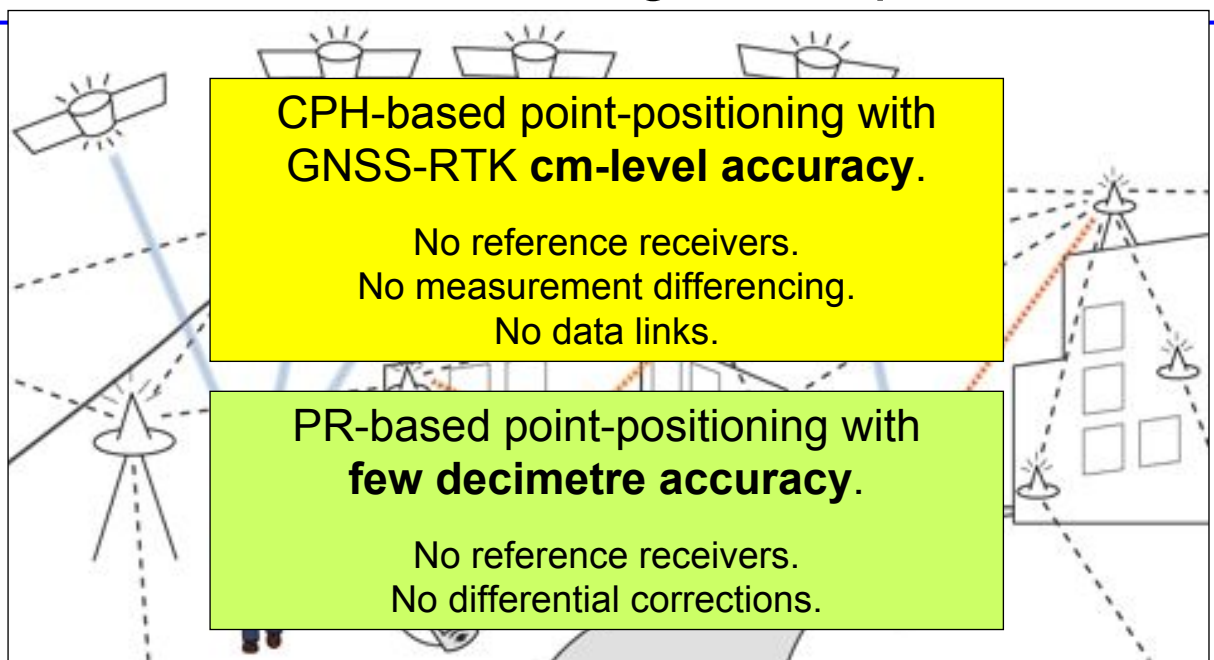
School of Surveying & Spatial Information Systems, UNSW, Sydney, Australia

## Introductory Remarks

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- GNSS signals can be obstructed outdoors leading to loss of availability, & *are vulnerable to RFI*.
- GNSS signals are attenuated indoors, & *cannot give performance similar to outdoors*.
- APNT systems such as *Locata* can address availability issues *both outdoors & indoors*, for land and air applications, *including at cm-accuracy*.
- New directional antenna technology appears to have addressed multipath & RFI issues.
- Now have option for indoor *local positioning system* with similar performance as (unobstructed GNSS).

# Locata Positioning Concept



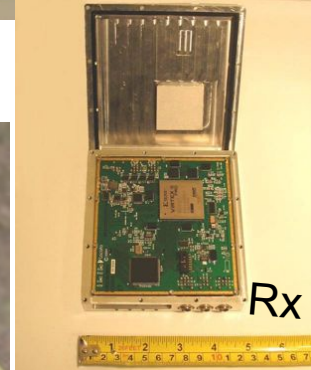
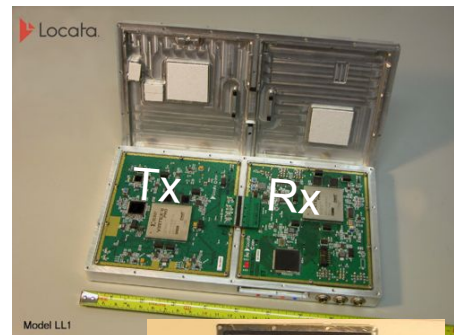
*Locata* receiver can use signals from *LocataNet*.

Integrated *Locata* & GNSS receiver possible for certain applications.

But once a *LocataNet* is established it can operate independently of GNSS.

# Locata *Current System*

- **Signal Structure**
  - Licence-free ISM frequency band (2.4GHz)
  - Dual-frequency carriers
  - Bespoke CDMA PRN codes - *ICD released Sept 2011 at ION-GNSS*
  - Precise TDMA pulsing - *for near-far problem*
  - >1 Watt output power - *range of over 10's km*
- **LocataLite**
  - Time-synchronised transceiver network
  - Dual Tx antennas
  - Prototype has modular board design based on FPGA technology
  - Uses low-cost clock (TCXO), shared by receiver section
- **Locata Receiver**
  - CPH or PR single point-positioning
  - CPH AR at known point or OTF
  - Real-time positioning at 10Hz



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# LocataLite Setup

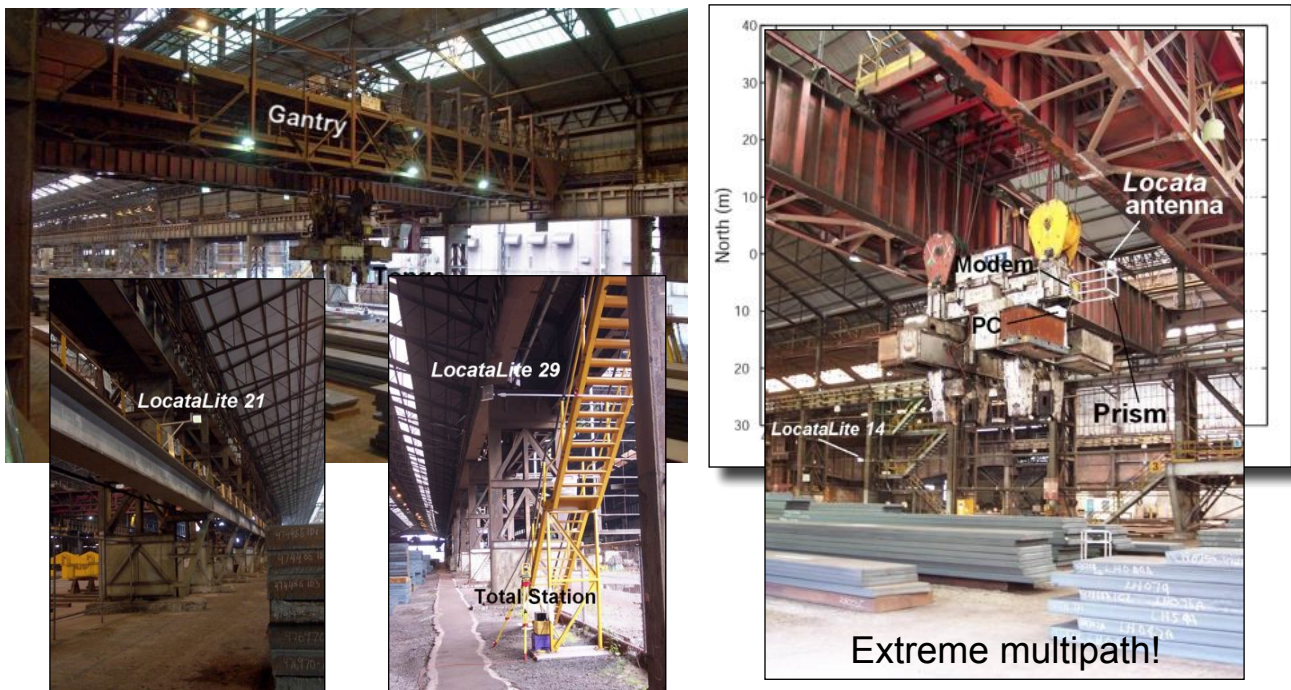
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# Industrial Machine Tracking *Locata* 2004

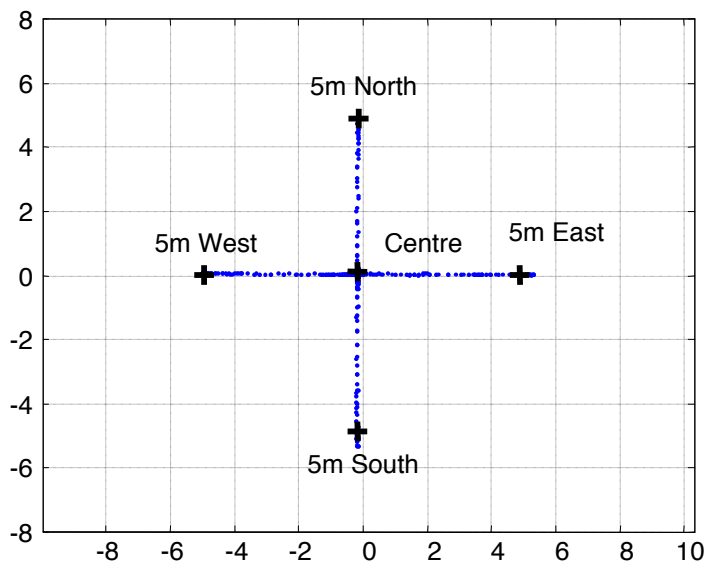
BlueScope Steelworks crane tracking (Wollongong, Australia)



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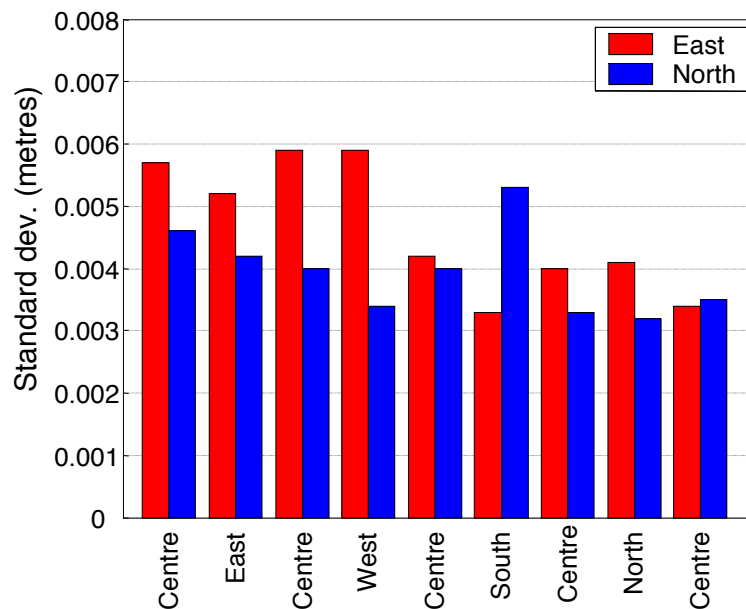
# Industrial Machine Tracking *Locata 2004*

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Crane tongs moved to 9 known points (measured with Total Station).

# Industrial Machine Tracking *Locata* 2004



Crane tongs moved to 9 known points (measured with Total Station).

Accuracy -

Max position error 1.8 cm

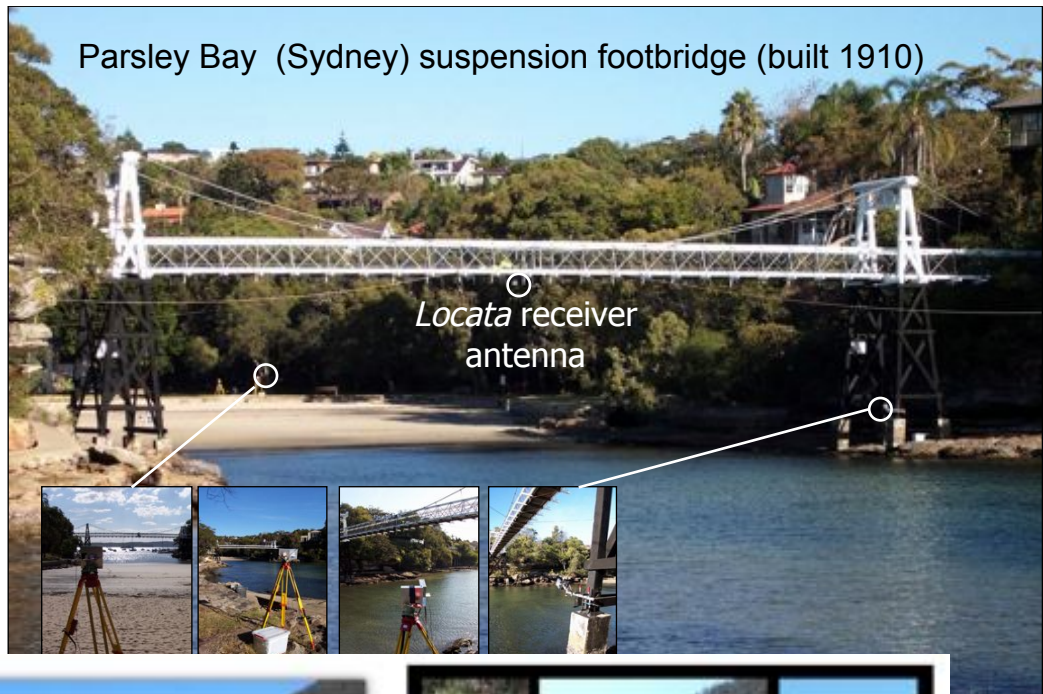
Precision -

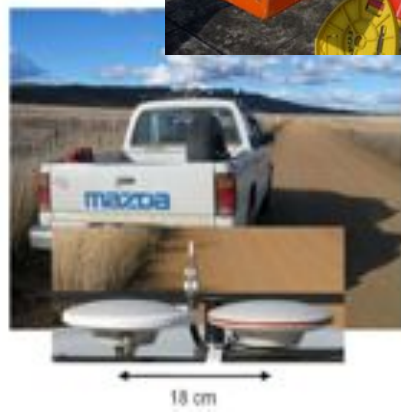
Standard deviation <0.6 cm

But multipath caused BIG problems



Parsley Bay (Sydney) suspension footbridge (built 1910)





## Outdoor Kinematic Tests 2006 - *Numerella*

*LocataLite*

	Elev. (deg)	Dist. (m)
1/2	4	1770
3/4	3	1205
5/6	0	270
7/8	0	589
11/12	54-19	17-45
13/14	1	300

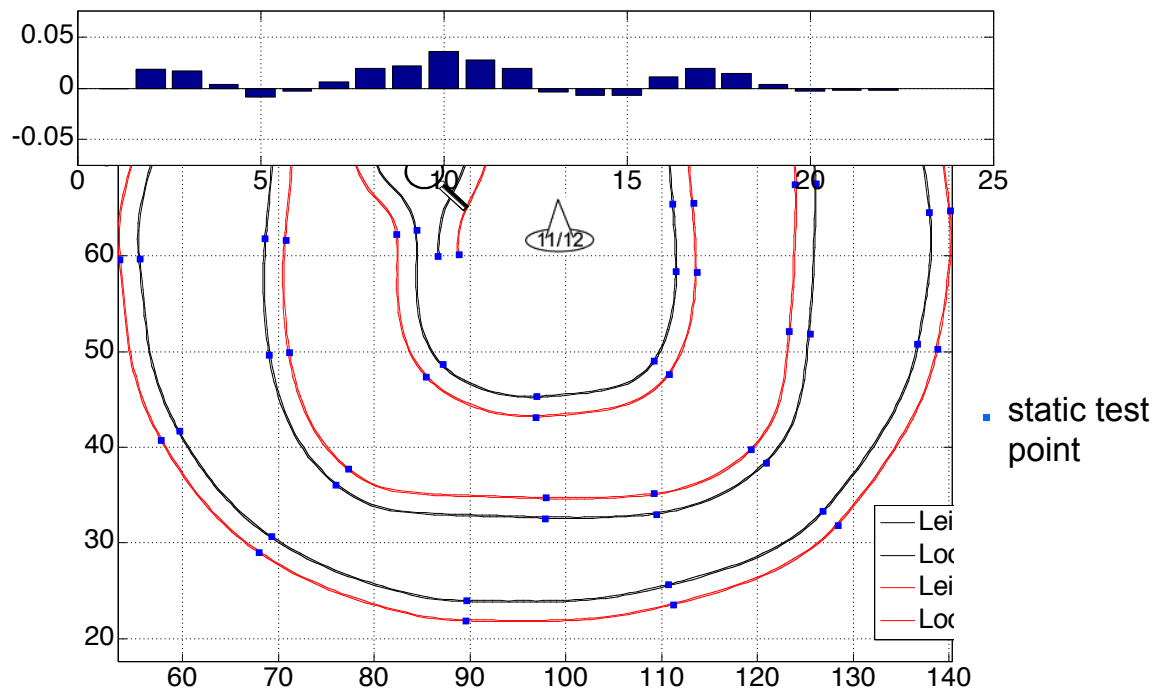
3/4 5/6 11/12 7/8 13/14



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# Trajectory GPS-RTK vs. *Locata*



## Indoor Testing *September 2010*

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- Indoor experiments conducted in a metal shed at Numerella (30m ! 15m).

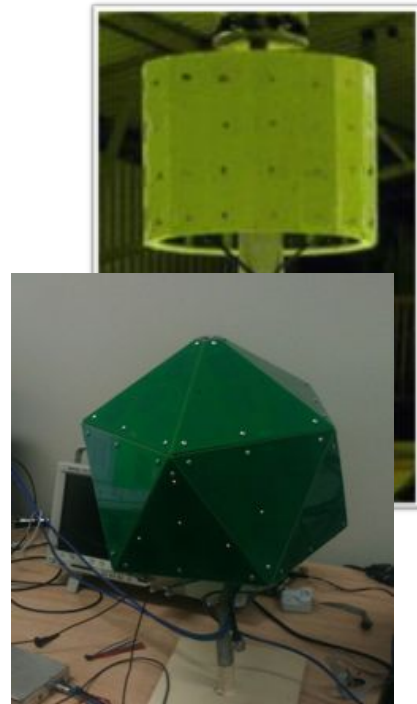


- Severe multipath environment for signals.

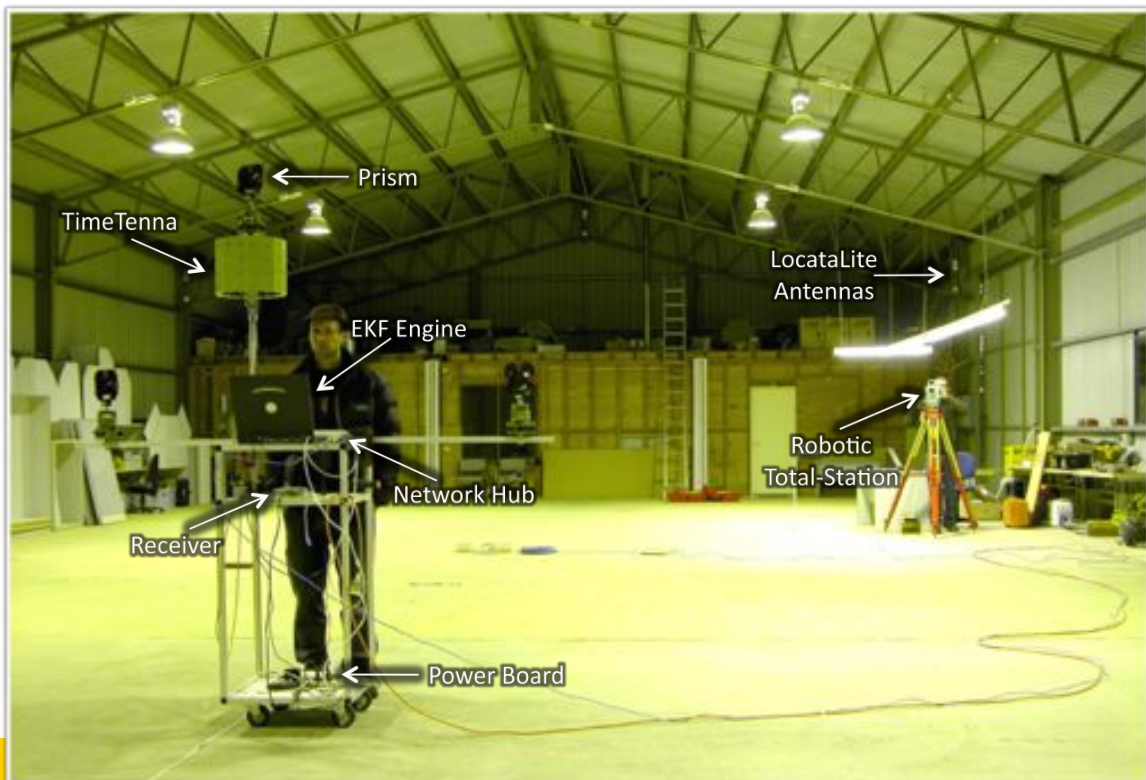
## *TimeTenna*

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- Uses an array of antenna elements & SW-controlled directional beams.
- Takes advantage of *Locata's* proprietary signal structure and time synchronisation.
- Dynamically tracks *only* direct line-of-sight ranging signals.
- Prototype 3D design.



# Indoor Test Setup



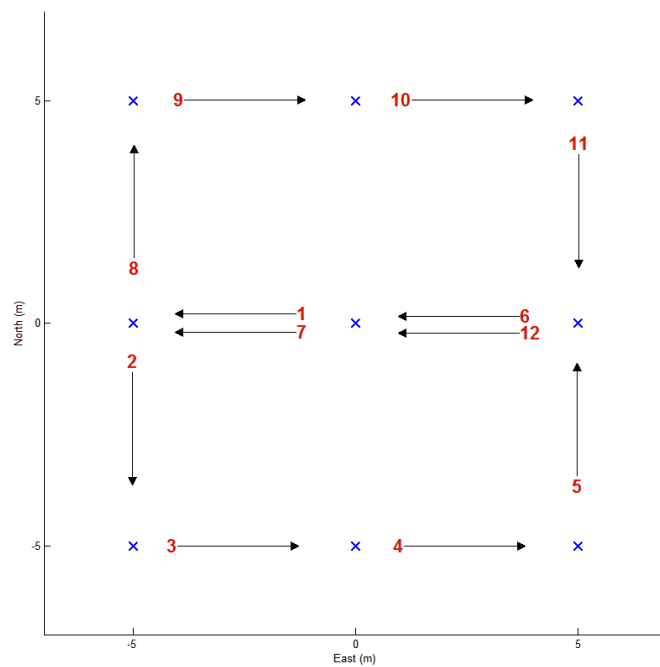
ION-UNSW, Portland, Oregon, USA, 20-26 September 2011



UNSW  
THE UNIVERSITY OF NEW SOUTH WALES

# Static Test

- Receiver moved between adjacent marked points.
- Static for at least one minute per point.



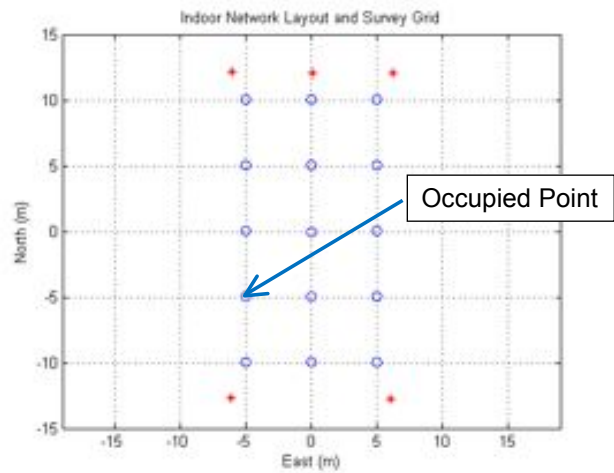
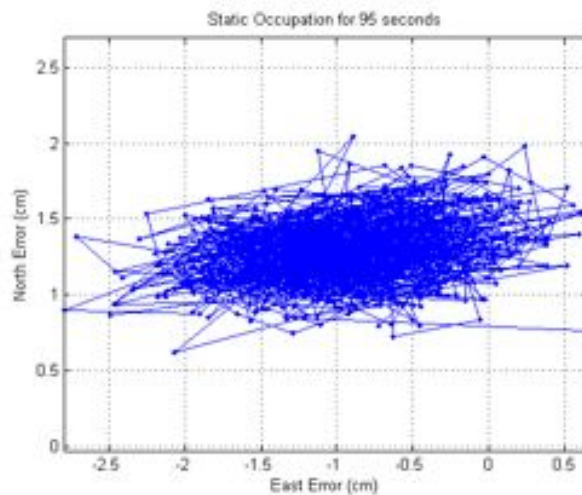


## Static Results

- RTS solutions considered as 'truth'.
- Nav Engine: (mostly) better than 2cm accuracy.
- EKF-based: better than 3cm accuracy (after convergence).

Point Index	Nav Error Distance (mm)	EKF Error Distance (mm)
1	7.0	633.0
2	19.7	287.9
3	12.8	7.1
4	7.1	12.2
5	2.9	6.5
6	5.2	23.5
7	9.3	24.7
8	0.7	16.9
9	42.6	0.3
10	18.5	5.5
11	12.1	21.0
12	8.7	23.0
13	8.5	16.3

# Positioning Test Results



MEAN - E:-0.00940,N:0.0129

1" RMS - E:0.01111,N:0.0131

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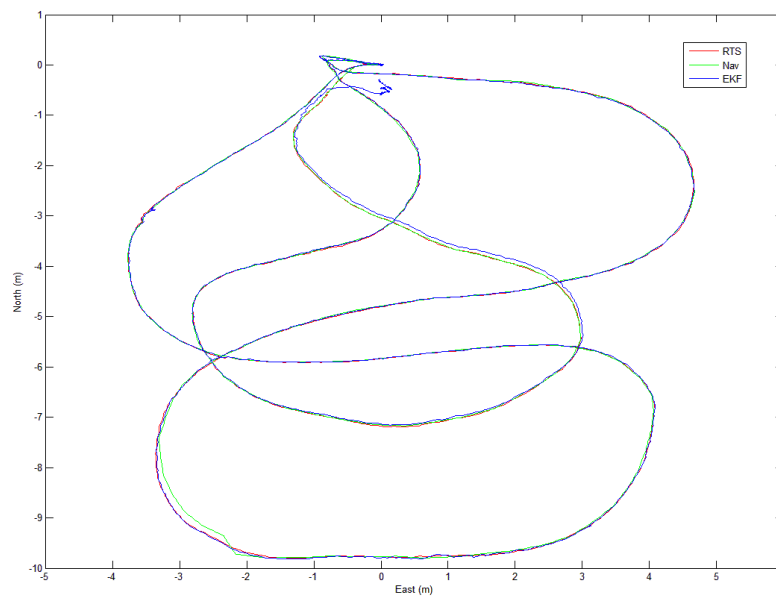
## Kinematic Test

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- Receiver started on initial known point.
- Moved continuously in a random pattern.
- The EKF-based solution converges after some initial movement.
- A *visual* inspection of the results confirms relative accuracy performance.

# Kinematic Results

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- *Majority of the trajectory errors less than 3cms*

## Orientation Test Results

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	Mean error (deg)	Max absolute error (deg)	95% RMS error (deg)
<b>0 Degrees</b>	<b>0.0555</b>	<b>1.2423</b>	<b>0.6336</b>
<b>90 Degrees</b>	<b>-0.1560</b>	<b>1.0121</b>	<b>0.6782</b>
<b>180 Degrees</b>	<b>0.3789</b>	<b>1.0303</b>	<b>0.7150</b>
<b>270 Degrees</b>	<b>-0.1595</b>	<b>1.0442</b>	<b>0.6317</b>

## Indoor Demos at ION-GNSS 2011

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## Concluding Remarks

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- First indoor tests in September 2010 of *Locata*'s new prototype antenna successfully demonstrated multipath mitigation.
- Live demos at ION-GNSS in September 2011.
- Robust cm-level indoor positioning accuracy for *industrial* applications is now a reality.
- Orientation accuracy at  $<1\text{deg}$ , using single antenna.
- ICD released at ION-GNSS.